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U.S. ENVIRONMENTAL PROTECTION AGENCY

Office of Radiation Programs

INTERNATIONAL NUMERICAL MULTIPLE AND SUBMULTIPLE PREFIXES

Multiples and submultiples	Prefixes	Symbols	Pronunciations
10^{12}	tera	T	tĕr'a
10^{9}	giga	G	jĭ'ga
10^{6}	mega	M	mĕg'a
10^{3}	kilo	k	kĭ'lo
10^{2}	hecto	h	hĕk'to
10	deka	da	dĕk'a
10^{-1}	deci	d	dĕs'i
10^{-2}	centi	c	sĕn'ti
10^{-3}	milli	m	mĭl'i
10^{-6}	micro	μ	mi'kro
10^{-9}	nano	n	năn'o
10^{-12}	pico	p	pē'ko
10^{-15}	femto	f	fĕm'to
10^{-18}	atto	a	ăt'to

SYMBOLS, UNITS, AND EQUIVALENTS

Symbol	Unit	Equivalent
Å	angstrom	10^{-10} meter
a	annum, year	
BeV	billion electron volts	GeV
Ci	curie	3.7×10^{10} dps
cm	centimeter(s)	0.394 inch
cpm	counts per minute	
dpm	disintegrations per minute	
dps	disintegrations per second	
eV	electron volt	1.6×10^{-12} ergs
g	gram(s)	
GeV	giga electron volts	1.6×10^{-3} ergs
kg	kilogram(s)	1,000 g = 2.205 lb.
km^2	square kilometer(s)	
kVp	kilovolt peak	
m^3	cubic meter(s)	
mA	milliampere(s)	
mCi/mi^2	millicuries per square mile	0.386 nCi/m^2 (mCi/km^2)
MeV	million (mega) electron volts	1.6×10^{-6} ergs
mg	milligram(s)	
mi^2	square mile(s)	
ml	milliliter(s)	
mm	millimeter(s)	
nCi/m^2	nanocuries per square meter	2.59 mCi/mi^2
pCi	picocurie(s)	10^{-12} curie = 2.22 dpm
R	roentgen	
rad	unit of absorbed radiation dose	100 ergs/g

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RADIATION DATA AND REPORTS

Volume 13, Number 7, July 1972

Radiation Data and Reports, a monthly publication of the Environmental Protection Agency, presents data and reports provided by Federal, State, and foreign governmental agencies, and other cooperating organizations. Pertinent original data and interpretive manuscripts are invited from investigators.

In August 1959, the President directed the Secretary of Health, Education, and Welfare to intensify Departmental activities in the field of radiological health. The Department was assigned responsibility within the Executive Branch for the collation, analysis, and interpretation of data on environmental radiation levels. This responsibility was delegated to the Bureau of Radiological Health, Public Health Service. Pursuant to the Reorganization Plan No. 3 of 1970, effective December 2, 1970, this responsibility was transferred to the Radiation Office of the Environmental Protection Agency which was established by this reorganization.

The Federal agencies listed below appoint their representatives to a Board of Editorial Advisors. Members of the Board advise on general publications policy; secure appropriate data and manuscripts from their agencies; and review those contents which relate to the special functions of their agencies.

- Department of Defense
- Department of Agriculture
- Department of Commerce
- Department of Health, Education, and Welfare
- Environmental Protection Agency
- Atomic Energy Commission

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U.S. ENVIRONMENTAL PROTECTION AGENCY

William D. Ruckelshaus, Administrator

Reports

Radiation Exposure to Staff Cardiologist vs. Senior Resident Cardiologist and Patients During Cardiac Catheterization

Stanley J. Malsky, Ph.D.,[1] *Jacob Haft, M.D.,*[2] *David Hayt, M.D.,*[3] *Lawrence Gould, M.D.,*[4] *Charles Blatt, M.D.,*[5] *Donald F. Simon, M.S.*[6] *and Bernard Roswit, M.D.*[7]

A study was conducted to compare the radiation exposure received by a senior resident cardiologist to that of the staff cardiologist when performing a full cardiac procedure. In addition, patient exposure values were obtained. The staff cardiologist was found to receive approximately 50–60 mR/procedure in the chest region and the senior resident received approximately 61 to 73 mR. The exposure to patients as calculated from tabletop measurements varied from 24 to 73 R.

The role of the medical physicist encompasses many responsibilities in the hospital setting. In diagnostic radiology, radiation therapy, and nuclear medicine, the assignments may include clinical, consultation, teaching, research, health physics and radiation protection studies. For diagnostic radiology, the responsibilities in part include technical assistance in the evaluation of diagnostic procedures in terms of possible dose reduction to patients and personnel, and evaluation of the performance of new diagnostic equipment. It was within the framework of the above criteria that this study was undertaken.

Background

A recent study by the Division of Medical Radiation Exposure, Bureau of Radiological Health (*1*) reported that between the years 1964 (*2*) and 1970, the use of medical x rays has increased over 25 percent. During this same period of time, complicated, time-consuming, new special procedures have increased patient exposure time in the radiological setting (*3–5*). One of these special diagnostic radiographic procedures, cardiac catheterization, may require from 2 to 4 hours and may incur considerable patient exposure time. These time factors therefore lead to the conclusion that both patient and support personnel could receive considerable doses of radiation.

In a preliminary paper (*6*), a dosimetry study was undertaken of the cardiac catheterization team for a number of full procedures; the present study is a continuation of the preliminary work.

Purpose of the study

This study attempts to compare the radiation exposure received by the senior resident cardiologist to that of the staff cardiologist when each performed a full cardiac procedure. Naturally, the level of difficulty in a particular case can nullify a particular comparison. The data obtained, therefore, are an average of total, live

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fluoroscopy time. A second part of this study was to obtain patient exposure values (R) and area exposed (cm^2) in terms of R–cm^2.

Dosimetry techniques

The dosimetry systems consisted of:

1. commercial, conventional, clip-on and wrist film badges, and
2. thermoluminescent (TL) lithium fluoride (LiF) wafers, 12.7 mm in diameter.

Individual film badges were issued only once to the medical staff per examination and then returned to the vendor for development and results. The film badges were worn by the cardiologist at the following locations:

1. collar level, outside lead apron.
2. chest level, outside lead apron.
3. chest level, inside lead apron.
4. wrist of hand, and
5. back, waist level, outside lead apron.

Thermoluminescent dosimetry techniques have been described in a number of papers (*7,8*) and texts (*9–11*) and will not be covered in this article in detail, other than to indicate that annealing, screening, quality control techniques were employed for the dosimeters prior to use. The TL discs were used in pairs: placed into a plastic bag, sealed, and then mounted on the underside of ordinary adhesive bandages (figure 1). These adhesive bandage dosimetry packages were then positioned on the following anatomical sites, adjacent (when applicable) to where film badges were stationed:

1. over the left eye,
2. over the right eye,
3. collar, outside lead apron,
4. chest, outside lead apron,
5. chest, inside lead apron,
6. wrist,
7. back, waist level, outside lead apron,
8. gonadal area, inside lead apron, and
9. gonadal area, outside lead apron.

Patient exposure (R–cm^2)

It is possible to obtain an approximate patient total exposure value by employing a reconstruction of the clinical study using a phantom and the various physical factors (kV, mAs, source-to-patient distance, and filtration). In dynamic studies, the ideal setting would be to obtain dosimetry information of the performance of the actual procedure. In an attempt to determine patient exposure over various portal sizes, an R–cm^2 unit was installed directly in front of the adjustable x-ray collimator. This unit serves to indicate that a patient has received a certain area dose which can be compared to that received by another patient: it is not an absolute value, but certain data and inferences can be obtained using this unit.

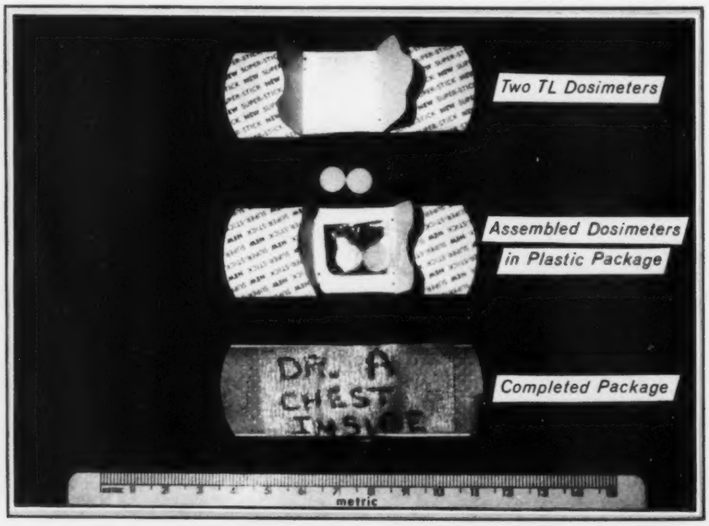

Figure. 1. Thermoluminescent dosimeter package

A commercial model of this system is the Diamentor.[*] It consists of a parallel plate ionization chamber, a preamplifier, and a control unit which has a digital readout and printer. The chamber is mounted directly in front of the adjustable diaphragm so that the entire x-ray beam always passes through it. The Diamentor is calibrated so that each step recorded is equivalent to an area exposure of 1 or 10 R–cm^2. Consider a skin dose with fields 8×8 cm (64 cm^2) and of 16×16 cm (256 cm^2); in the latter case approximately four times the radiation has been delivered. The chamber therefore has value in terms of:

1. an approximation of patient area exposure, and
2. in a residency training program, it could serve as a measure of residency ability, and finally
3. as a health physics guide in the cardiology department.

The physical characteristics of the x-ray system as employed in this study are:

1. full-wave rectification, single phase,
2. voltage-125 kV (65–100 kVp actual), current-300 mA.,
3. live time: 5 to 20 minutes (fluoroscopy); cine time: up to 4 minutes; total procedural time: 1–4 hours,
4. filter—2.5 mm aluminum added, plus 0.5 mm aluminum inherent plus 0.4 mm aluminum equivalent for the parallel plate ionization chamber (Diamentor). Total filtration: 3.4 mm aluminum equivalent,
5. tabletop measurement: 3.0 R/min. at 100 kVp at a source to table distance of 38 cm: 10×10 cm field,
6. image intensifier face—22 cm diameter,
7. table top field size: 60–180 cm^2, and
8. automatic brightness control.

The above factors contain some changes from the original study (*6*). Basically, the total filtration has increased slightly due to the addition of the ionization chamber on the adjustable collimator. The field size at the fluoroscope screen has generally been reduced from a range of 180–300 cm^2 to a range of 150–250 cm^2.

[*] Nuclear Associates, Westbury, Long Island, N.Y.

Procedure

The Judkens technique for coronary arteriography was employed in all cases. The catheterization team consists of three physicians, a nurse and a technician. The approximate location of each member is shown in figure 2. All personnel wear 0.5-mm lead rubber aprons. There is no lead overleaf or flexible lead rubber drape about the radiographic tube. The physician performing the procedure does not wear lead rubber gloves. The radiation field intensities (mR/h) were measured using suitable ionization chamber rate meters.

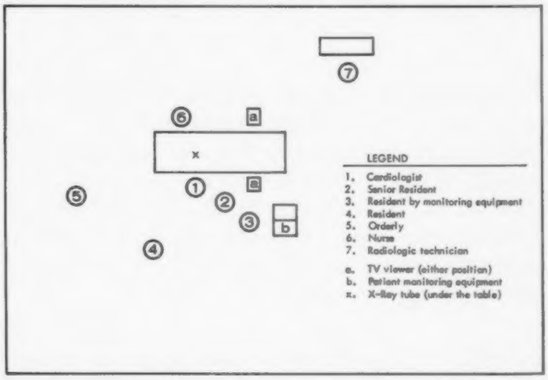

Figure 2. Approximate location of personnel during a cardiac procedure

As far as possible during fluoroscopy, the direct beam was limited to the cardiac silhouette. The dimensions of the field varied with the heart size. The live time varied with:

1. the difficulty ascribed to each patient, and
2. whether the senior cardiac resident or the senior medical member performed the study.

Results

Of the 12 patients (adult males) receiving a full cardiac catheterization procedure, the exposure as calculated from tabletop measurements varied from 24 to 73 R. The portal size at the posterior of the patient ranged from 60 cm^2 to 180 cm^2. The corresponding R–cm^2 readings were in the range of 1,420 to 4,700 R–cm^2 with an average of 2,100 R–cm^2.

Exposure data for medical personnel performing the studies are contained in table 1.

Table 1. Summary of dosimetry readings for full cardiac procedure

Location of dosimeters[a]	Staff cardiologist		Senior resident cardiologist	
	Range (mR)	Mean (mR)	Range (mR)	Mean (mR)
Eye area (TL)	16–20	18	16–44	30
Collar (F)	17–55	36	20–68	44
Collar (TL)	19–29	24	24–42	33
Chest (O, F)	278–700	489	290–850	570
Chest (O, TL)	330–700	515	409–720	564
Chest (I, F)	30–70	50	41–81	61
Chest (I, TL)	40–80	60	48–99	73
Wrist (F)	102–161	131	100–170	135
Wrist (TL)	119–177	148	124–185	154
Back (F)	<10–19	10	<10–18	10
Back (TL)	<10–20	10	<10–24	10
Gonads (I, F)	<10	<10	<10	<10
Gonads (I, TL)	<10	<10	<10	<10

[a] F, film dosimetry; TL, thermoluminescent dosimetry; O, outside lead gown; I, inside lead gown.

As can be noted from the data, the senior staff receives on the average, approximately 1/3 to 1/2 of the maximum weekly permissible dose to the trunk of the body if a single full procedure is performed without assistance. A senior cardiac resident receives approximately 25 percent more to the same body part as a result of his general limited experience.

Discussion

This study attempted to determine medical staff (senior staff and senior residents) exposure to various anatomical sites while performing a full cardiac catheterization, and an estimate of patient area exposure.

Personnel exposure was measured by the techniques of film badges and thermoluminescent dosimetry. Patient exposure was determined using live-time data, R/mm tabletop measurements, and R–cm^2 for area exposure.

While it is understood that the R–cm^2 data are not absolute values, and that integral dose in terms of kilogram-rad or millijoules for the measurement of radiant energy may be desirable, the mode of recording patient area exposure in the R–cm^2 unit does serve a purpose. In a teaching hospital, the R–cm^2 unit can serve as a measure (at first approximation) of area dose received by patients during procedures conducted by various residents or senior staff. It may also serve with suitable mathematical modeling as a means of comparison of integral doses.

It should be noted that it is highly desirable that the consulting services of a radiologist and a medical physicist be available, and they should be considered as an integral advisory part of that service.

Future projections

The following areas are being explored:

1. comparison studies between hospitals are in progress,
2. patient (male, female and children); gonadal information is essential and is being obtained,
3. investigation of the use of image storage systems as a mode of reducing both personnel and patient exposure. One such system, developed by Cameron et al.[9] and viewed using phantoms, shows promise and possible application in fluoroscopic examination, and
4. further studies with the R–cm^2 unit in terms of resident training and health physics are continuing and an attempt will be made to relate these values to integral dose of the patient.

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[9] Personal communication from J. R. Cameron.

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SECTION I. MILK AND FOOD

Milk Surveillance, March 1972

Although milk is only one of the sources of dietary intake of environmental radioactivity, it is the food item that is most useful as an indicator of the general population's intake of radionuclide contaminants resulting from environmental releases. Fresh milk is consumed by a large segment of the population and contains several of the biologically important radionuclides that may be released to the environment from nuclear activities. In addition, milk is produced and consumed on a regular basis, is convenient to handle and analyze, and samples representative of general population consumption can be readily obtained. Therefore, milk sampling networks have been found to be an effective mechanism for obtaining information on current radionuclide concentrations and long-term trends. From such information, public health agencies can determine the need for further investigation or corrective public health action.

The Pasteurized Milk Network (PMN) sponsored by the Office of Radiation Programs, Environmental Protection Agency, and the Office of Food Sanitation, Food and Drug Administration, Public Health Service, consists of 63 sampling stations: 61 located in the United States, one in Puerto Rico, and one in the Canal Zone. Many of the State health departments also conduct local milk surveillance programs which provide more comprehensive coverage within the individual State. Data from 15 of these State networks are reported routinely in *Radiation Data and Reports*. Additional networks for the routine surveillance of radioactivity in milk in the Western Hemisphere and their sponsoring organizations are:

Pan American Milk Sampling Program (Pan American Health Organization and U.S. Environmental Protection Agency)—5 sampling stations

Canadian Milk Network (Radiation Protection Division, Canadian Department of National Health and Welfare)—16 sampling stations.

The sampling locations that make up the networks presently reporting in *Radiation Data and Reports* are shown in figure 1. Based on the similar purpose for these sampling activities, the present format integrates the complementary data that are routinely obtained by these several milk networks.

Radionuclide and element coverage

Considerable experience has established that relatively few of the many radionuclides that are formed as a result of nuclear fission become incorporated in milk (*1*). Most of the possible radiocontaminants are eliminated by the selective metabolism of the cow, which restricts gastrointestinal uptake and secretion into the milk. The five fission-product radionuclides which commonly occur in milk are strontium-89, strontium-90, iodine-131, cesium-137, and barium-140. A sixth radionuclide, potassium-40, occurs naturally in 0.0118 percent (*2*) abundance of the element potassium, resulting in a specific activity for potassium-40 of 830 pCi/g total potassium.

Two stable elements which are found in milk, calcium and potassium, have been used as a means for assessing the biological behavior of

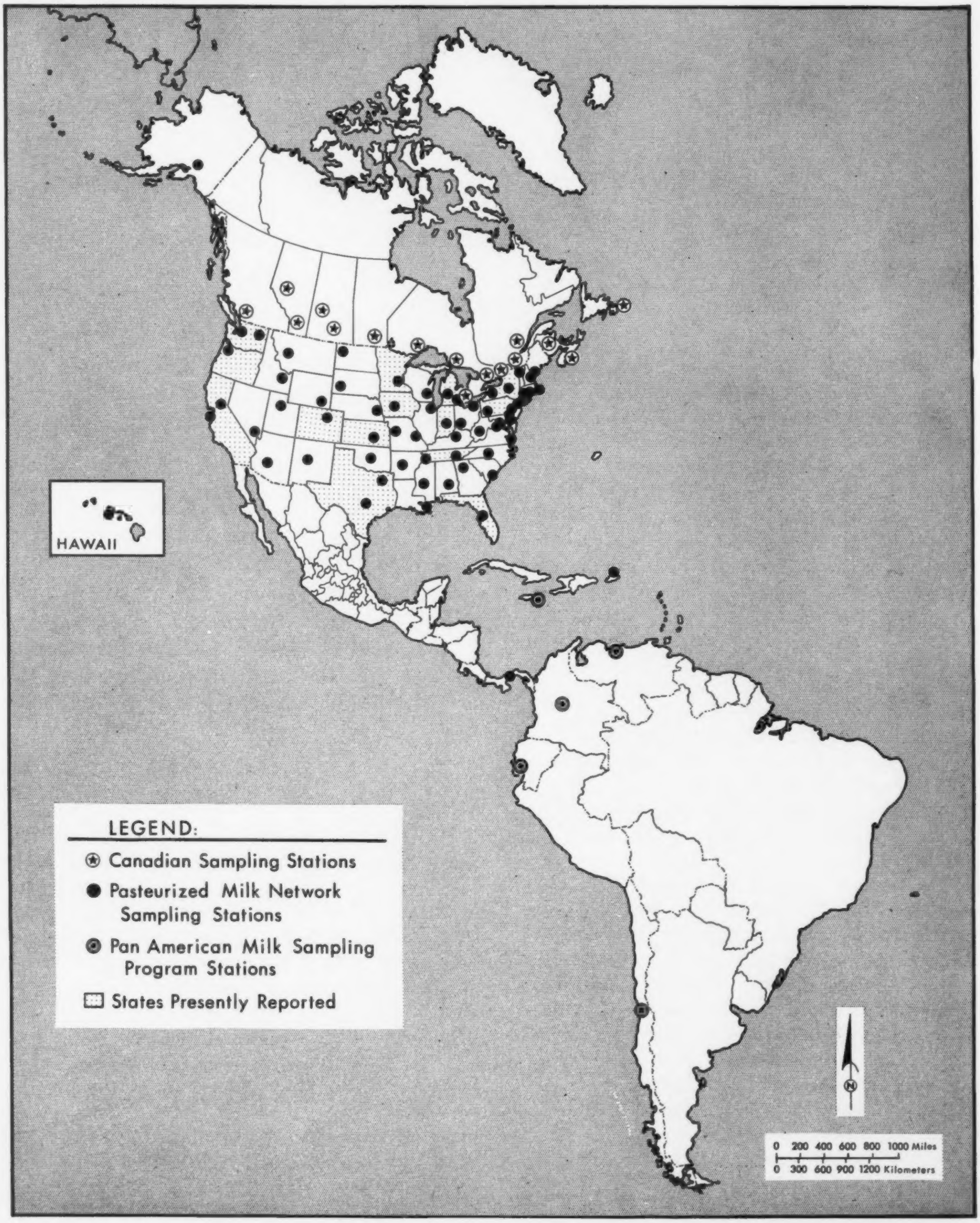

Figure 1. Milk sampling networks in the Western Hemisphere

metabolically similar radionuclides (radiostrontium and radiocesium, respectively). The contents of both calcium and potassium in milk have been measured extensively and are relatively constant. Appropriate values and their variations, expressed in terms of 2 standard deviations (2σ), for these elements are 1.16 ± 0.08 g/liter for calcium and 1.51 ± 0.21 g/liter for potassium. These figures are averages of data from the PMN for May 1963–March 1966 (*3*) and were determined for use in general radiological health calculations or discussions.

Accuracy of data from various milk networks

In order to combine data from the international, national, and State networks considered in this report, it was first necessary to determine the accuracy with which each laboratory is making its determinations and the agreement of the measurements among the laboratories. The Analytical Quality Control Service of the Office of Radiation Programs conducts periodic studies to assess the accuracy of determinations of radionuclides in milk performed by interested radiochemical laboratories. The generalized procedure for making such a study has been outlined previously (*4*).

The most recent study was conducted during July 1971 with 37 laboratories participating in an experiment on a milk sample containing known concentrations of iodine-131, cesium-137, strontium-89, and strontium-90 (*5*). Of the 17 laboratories producing data for the networks reporting in *Radiation Data and Reports*, 14 participated in the experiment.

The accuracy results of this experiment for these 14 laboratories are shown in table 1. Considerable improvement has been made in the accuracy of the analyses of all radionuclides compared to the results of previous studies. Some improvement is still needed in the technique for determining the strontium-90 results. These possible differences should be kept in mind when considering the integration of data from the various networks.

Development of a common reporting basis

Since the various networks collect and analyze samples differently, a complete understanding of several parameters is useful for interpreting the data. Therefore, the various milk surveillance networks that report regularly were surveyed for information on analytical methods, sampling and analysis frequencies, and estimated analytical errors associated with the data.

In general, radiostrontium is collected by an ion-exchange technique and determined by beta-particle counting in low-background detectors, and the gamma-ray emitters (potassium-40, iodine-131, cesium-137, and barium-140) are determined by gamma-ray spectroscopy of whole milk. Each laboratory has its own modifications and refinements of these basic methodologies. The methods used by each of the networks have been referenced in earlier reports appearing in *Radiological Health Data and Reports*.

A previous article (*6*) summarized the criteria used by the State networks in setting up their milk sampling activities and their sample collection procedures as determined during a 1965 survey. This reference and an earlier data

Table 1. Distribution of mean results, quality control experiment

Isotope and known concentration	Number of laboratories in each category			
	Acceptable[a]	Warning level[b]	Unacceptable[c]	Total
Iodine-131 (69 pCi/liter)	13 (100%)	0	0	13
Cesium-137 (52 pCi/liter)	12 (92%)	1 (8%)	0	13
Strontium-89 (31 pCi/liter)	9 (90%)	1 (10%)	0	10
Strontium-90 (41.6 pCi/liter)	9 (69%)	1 (8%)	3 (23%)	13

[a] Measured concentration equal to or within 2σ of the known concentration.
[b] Measured concentration outside 2σ and equal to or within 3σ of the known concentration.
[c] Measured concentration outside 3σ of the known concentration.

article for the particular network of interest may be consulted should events require a more definitive analysis of milk production and milk consumption coverage afforded by a specific network.

Many networks collect and analyze samples on a monthly basis. Some collect samples more frequently but composite the several samples for one analysis, while others carry out their analyses more often than once a month. Many networks are analyzing composite samples on a quarterly basis for certain nuclides. The frequency of collection and analysis varies not only among the networks but also at different stations within some of the networks. In addition, the frequency of collection and analysis is a function of current environmental levels. The number of samples analyzed at a particular sampling station under current conditions is reflected in the data presentation. Current levels for strontium-90 and cesium-137 are relatively stable over short periods of time, and sampling frequency is not critical. For the short-lived radionuclides, particularly iodine-131, the frequency of analysis is critical and is generally increased at the first measurement or recognition of a new influx of this radionuclide.

The data in table 2 shows whether raw or pasteurized milk was collected. An analysis (*7*) of raw and pasteurized milk samples collected during January 1964 to June 1966 indicated that for relatively similar milkshed or sampling areas, the differences in concentration of radionuclides in raw and pasteurized milk are not statistically significant (*7*). Particular attention was paid to strontium-90 and cesium-137 in that analysis.

Practical reporting levels were developed by the participating networks, most often based on 2-standard-deviation counting errors or 2-standard-deviation total analytical errors from replicate analyses (*3*). The practical reporting level reflects analytical factors other than statistical radioactivity counting variations and will be used as a practical basis for reporting data.

The following practical reporting levels have been selected for use by all networks whose practical reporting levels were given as equal to or less than the given value.

Radionuclide	Practical reporting level (pCi/liter)
Strontium-89	5
Strontium-90	2
Iodine-131	10
Cesium-137	10
Barium-140	10

Some of the networks gave practical reporting levels greater than those above. In these cases, the larger value is used so that only data considered by the network as meaningful will be presented. The practical reporting levels apply to the handling of individual sample determinations. The treatment of measurements equal to or below these practical reporting levels for calculation purposes, particularly in calculating monthly averages, is discussed in the data presentation.

Analytical error or precision expressed as pCi/liter or percent in a given concentration range has also been reported by the networks (*3*). The precision errors reported for each of the radionuclides fall in the following ranges:

Radionuclide	Analytical errors of precision (2 standard deviations)
Strontium-89	1–5 pCi/liter for levels <50 pCi/liter; 5–10% for levels ≧ 50 pCi/liter;
Strontium-90	1–2 pCi/liter for levels <20 pCi/liter; 4–10% for levels ≧ 20 pCi/liter;
Iodine-131 Cesium-137 Barium-140	4–10 pCi/liter for levels <100 pCi/liter; 4–10% for levels ≧100 pCi/liter.

For iodine-131, cesium-137, and barium-140, there is one exception for these precision error ranges: 25 pCi/liter at levels <100 pCi/liter for Colorado. This is reflected in the practical reporting level for the Colorado milk network.

Federal Radiation Council guidance applicable to milk surveillance

In order to place the U.S. data on radioactivity in milk presented in *Radiation Data and Reports* in perspective, a summary of the guidance provided by the Federal Radiation Council

Table 2. Concentrations of radionuclides in milk for March 1972 and 12-month period, April 1971 through March 1972

Sampling location		Type of sample[a]	Radionuclide concentration (pCi/liter)			
			Strontium-90		Cesium-137	
			Monthly average[b]	12-month average	Monthly average[b]	12-month average
UNITED STATES:						
Ala:	Montgomery[c]	P	NA	7	19	10
Alaska:	Palmer[c]	P	4	5	7 (2)	12
Ariz:	Phoenix[c]	P	NA	0	0 (2)	0
Ark:	Little Rock[c]	P	NA	12	7 (2)	15
Calif:	Sacramento[c]	P	NA	1	0 (2)	0
	San Francisco[c]	P	NA	4	0	0
	Del Norte	P	12	13	0	12
	Fresno	P	2	2	0	5
	Humboldt	P	4	3	0	6
	Los Angeles	P	0	2	0	4
	Mendocino	P	NA	7	0	9
	Sacramento	P	2	3	0	5
	San Diego	P	0	1	0	4
	Santa Clara	P	0	2	0	7
	Shasta	P	2	3	11	7
	Sonoma	P	3	3	7	7
Colo:	Denver[c]	P	NA	5	6 (2)	9
	East	R	(d)		[e]0 (2)	[e]0
	Northeast	R	(d)		NS	[e]1
	Northwest	R	(d)		[e]0	[e]0
	South Central	R	(d)		NS	
	Southeast	R	(d)		[e]0	[e]0
	Southwest	R	(d)		[e]0	[e]2
	West	R	(d)		[e]0	[e]0
Conn:	Hartford[c]	P	NA	7	14 (2)	9
	Central	P	7	7	15	15
Del:	Wilmington[c]	P	NA	8	0	4
D.C:	Washington[c]	P	NA	8	11	9
Fla:	Tampa[c]	P	4	5	37 (4)	41
	Central	R	5	6	37	44
	North	R	NA	10	17	24
	Northeast	R	7	7	17	35
	Southeast	R	3	6	54	54
	Tampa Bay area	R	4	6	36	40
	West	R	8	11	16	20
Ga:	Atlanta[c]	P	NA	10	12 (2)	16
Hawaii:	Honolulu[c]	P	3	3	0	2
Idaho:	Idaho Falls[c]	P	5	5	0 (2)	1
Ill:	Chicago[c]	P	7	7	17 (2)	10
Ind:	Indianapolis[c]	P	NA	7	8 (2)	5
	Central	P	8	7	15	13
	Northeast	P	6	6	15	15
	Northwest	P	8	8	15	15
	Southeast	P	7	8	15	15
	Southwest	P	8	9	10	15
Iowa:	Des Moines[c]	P	NA	6	0 (2)	2
	Des Moines	P	6	6	9 (3)	11
	Iowa City	P	6	7	13	10
	Little Cedar	P	8	7	13	13
	Spencer	P	6	6	11	12
Kans:	Wichita[c]	P	NA	8	0 (2)	2
	Coffeyville	P	8	8	16	14
	Dodge City	P	4	6	7	9
	Falls City, Nebr	P	11	4	6	7
	Hays	P	8	10	14	9
	Kansas City	P	9	9	13	12
	Topeka	P	8	8	17	10
	Wichita	P	8	9	4	12
Ky:	Louisville[c]	P	NA	8	14 (2)	8
La:	New Orleans[c]	P	15	14	11 (2)	16
Maine:	Portland[c]	P	NA	8	18 (2)	20
Md:	Baltimore[c]	P	NA	8	0	5
Mass:	Boston[c]	P	7	8	11 (2)	11
Mich:	Detroit[c]	P	NA	7	13 (2)	10
	Grand Rapids[c]	P	NA	9	13 (2)	10
	Bay City	P	0	6	18	15
	Charlevoix	P	NS	10	NS	15
	Detroit	P	0	6	8 (2)	11
	Grand Rapids	P	6	6	0	9
	Lansing	P	4	7	16 (2)	16
	Marquette	P	4	8	24 (2)	24
	Monroe	P	3	4	8 (2)	4
	South Haven	P	2	6	16 (5)	10
Minn:	Minneapolis[c]	P	NA	8	18 (2)	17
	Bemidji	P	8	8	22	20
	Duluth	P	14	16	28	29
	Fergus Falls	P	6	8	16	17
	Little Falls	P	16	17	13	20
	Mankato	P	6	7	13	12
	Minneapolis	P	10	13	17	17

See footnotes at end of table.

Table 2. Concentration of radionuclides in milk for March 1972 and 12-month period, April 1971 through March 1972—continued

Sampling location		Type of sample[a]	Radionuclide concentration (pCi/liter)			
			Strontium-90		Cesium-137	
			Monthly average[b]	12-month average	Monthly average[b]	12-month average
UNITED STATES:						
Minn:	Rochester	P	8	16	0	14
	Worthington	P	7	6	14	12
Miss:	Jackson[c]	P	NA	13	8 (2)	10
Mo:	Kansas City[c]	P	NA	8	6 (2)	7
	St. Louis[c]	P	NA	5	9 (2)	6
Mont:	Helena[c]	P	NA	6	6 (2)	9
Nebr:	Omaha[c]	P	NA	7	6 (2)	4
Nev:	Las Vegas[c]	P	NA	2	0 (2)	1
N.H:	Manchester[c]	P	NA	8	21 (2)	19
N.J:	Trenton[c]	P	NA	8	15 (2)	9
N. Mex:	Albuquerque[c]	P	NA	2	0 (2)	0
N.Y:	Buffalo[c]	P	6	7	8 (2)	7
	New York City[c]	P	NA	8	10 (2)	11
	Syracuse[c]	P	NA	7	8 (2)	8
	Albany	P	10	6	[d]0 (6)	[d]0
	Buffalo	P	3	0	[d]14	[d]0
	Massena	P	8	6	[d]0 (2)	[d]0
	New York City	P	7	7	[d]0	[d]0
	Syracuse	P	NS		NS	
N.C:	Charlotte[c]	P	NA	10	13	12
N. Dak:	Minot[c]	P	NA	9	20 (2)	14
Ohio:	Cincinnati[c]	P	NA	6	7 (2)	1
	Cleveland[c]	P	NA	7	6 (2)	7
Okla:	Oklahoma City[c]	P	NA	6	8 (2)	8
Oreg:	Portland[c]	P	4	5	0 (2)	6
	Baker	P	NA		NA	
	Coos Bay	P	NA		NA	
	Eugene	P	NA		NA	
	Medford	P	NA		NA	
	Portland composite	P	NA		NA	
	Portland local	P	NA		NA	
	Redmond	P	NA		NA	
	Tillamook	P	NA		NA	
Pa:	Philadelphia[c]	P	NA	8	0	5
	Pittsburgh[c]	P	NA	10	16	6
	Dauphin	P	5	7	13	11
	Erie	P	0	8	20	15
	Philadelphia	P	0	5	12	15
	Pittsburgh	P	8	7	21	14
R.I:	Providence[c]	P	NA	8	17 (2)	12
S.C:	Charleston[c]	P	10	9	14 (2)	15
S. Dak:	Rapid City[c]	P	NA	6	0 (2)	7
Tenn:	Chattanooga[c]	P	NA	8	8 (2)	11
	Memphis[c]	P	NA	7	0 (2)	7
	Chattanooga	P	12	10	15 (2)	14
	Clinton	R	10	9	19 (2)	14
	Fayetteville	R	14	10	17 (3)	7
	Kingston	R	14	9	16 (2)	10
	Knoxville	P	10	8	18 (2)	10
	Lawrenceburg	R	11	8	24 (2)	7
	Nashville	P	9	8	14 (2)	7
	Pulaski	R	7	8	7 (2)	4
Tex:	Austin[c]	P	NA	2	0 (2)	0
	Dallas[c]	P	NA	6	0 (2)	3
	Amarillo	R	6	4	0	0
	Corpus Christi	R	NS	5	NS	0
	El Paso	R	NS	3	NS	0
	Fort Worth	R	NS	4	NS	0
	Harlingen	R	3	4	0	0
	Houston	R	NS	8	NS	8
	Lubbock	R	NS	4	NS	0
	Midland	R	NS	3	NS	0
	San Antonio	R	4	5	0	0
	Texarkana	R	11	11	0	0
	Tyler	R	NS	10	NS	10
	Wichita Falls	R	NS	7	NS	5
Utah:	Salt Lake City[c]	P	6	5	16 (2)	11
Vt:	Burlington[c]	P	NA	6	16 (2)	11
Va:	Norfolk[c]	P	NA	8	0	5
Wash:	Seattle[c]	P	NA	5	0 (2)	6
	Spokane[c]	P	NA	6	16 (2)	7
	Benton County	R	0	1	0	0
	Franklin County	R	NS	1	NS	6
	Sandpoint, Idaho	R	14	12	18	22
	Skagit County	R	5	8	0	9
W. Va:	Charleston[c]	P	NA	8	0	6
Wisc:	Milwaukee[c]	P	NA	6	9 (2)	6
Wyo:	Laramie[c]	P	NA	4	0 (2)	2

See footnotes at end of table.

Table 2. Concentration of radionuclides in milk for March 1972 and 12-month period, April 1971 through March 1972—continued

Sampling location		Type of sample[a]	Radionuclide concentration (pCi/liter)			
			Strontium-90		Cesium-137	
			Monthly average[b]	12-month average	Monthly average[b]	12-month average
CANADA:						
Alberta:	Calgary	P	7	7	22	20
	Edmonton	P	7	7	21	24
British Columbia:	Vancouver	P	6	9	23	26
Manitoba:	Winnipeg	P	8	8	23	24
New Bruswick:	Fredericton	P	11	12	21	22
Newfoundland:	St. John's	P	14	18	18	34
Nova Scotia:	Halifax	P	8	11	19	25
Ontario:	Ottawa	P	5	6	13	14
	Sault Ste. Marie	P	11	13	26	32
	Thunder Bay	P	10	11	22	25
	Toronto	P	4	5	10	13
	Windsor	P	3	5	8	10
Quebec:	Montreal	P	7	7	13	17
	Quebec	P	9	10	27	29
Saskatchewan:	Regina	P	7	7	23	17
	Saskatoon	P	7	9	20	19
CENTRAL AND SOUTH AMERICA:						
Canal Zone:	Cristobal[c]	P	NA	0	0	4
Chile:	Santiago	P	0	0	0	2
Colombia:	Bogota	P	0	1	0	0
Ecuador:	Guayaquil	P	0	0	0	0
Jamaica:	Mandeville	P	NS	4	NS	58
Puerto Rico:	San Juan[c]	P	NA	4	0	10
Venezuela:	Caracas	P	0	0	0	0
PMN network average[f]			6	7	8	8

[a] P, pasteurized milk.
R, raw milk.

[b] When an individual sampling result was equal to or less than the practical reporting level, a value of "0" was used for averaging. Monthly averages less than the practical reporting level reflect the fact that some but not all of the individual samples making up the average contained levels greater than the practical reporting level. When more than one analysis was made in a monthly period, the number of samples in the monthly average is given in parentheses.

[c] Pasteurized Milk Network station. All other sampling locations are part of the State or National network.

[d] Radionuclide analysis not routinely performed.

[e] The practical reporting levels for these networks differ from the general ones given in the text. Sampling results for the networks were equal to or less than the following practical reporting levels:

Iodine-131:	Colorado—25 pCi/liter	Cesium-137:	Colorado—25 pCi/liter	Strontium-90:	New York—3 pCi/liter
	Michigan—14 pCi/liter		New York—20 pCi/liter		
	Oregon—15 pCi/liter		Oregon—15 pCi/liter		

[f] This entry gives the average radionuclides concentrations for the Pasteurized Milk Network stations denoted by footnote [c].
NA, no analysis.
NS, no sample collected.

for specific environmental conditions was presented in the December 1970 issue of *Radiological Health Data and Reports*.

Data reporting format

Table 2 presents the integrated results of the international, national, and State networks discussed earlier. Column 1 lists all the stations which are routinely reported to *Radiation Data and Reports*. The relationship between the PMN stations and the State stations is shown in figure 2. The first column under each of the reported radionuclides gives the monthly average for the station and the number of samples analyzed in that month in parentheses. When an individual sampling result is equal to or below the practical reporting level for the radionuclide, a value of zero is used for averaging. Monthly averages are calculated using the above convention. Averages which are equal to or less than the practical reporting levels reflect the presence of radioactivity in some of the individual samples greater than the practical reporting level.

The second column under each of the radionuclides reported gives the 12-month average

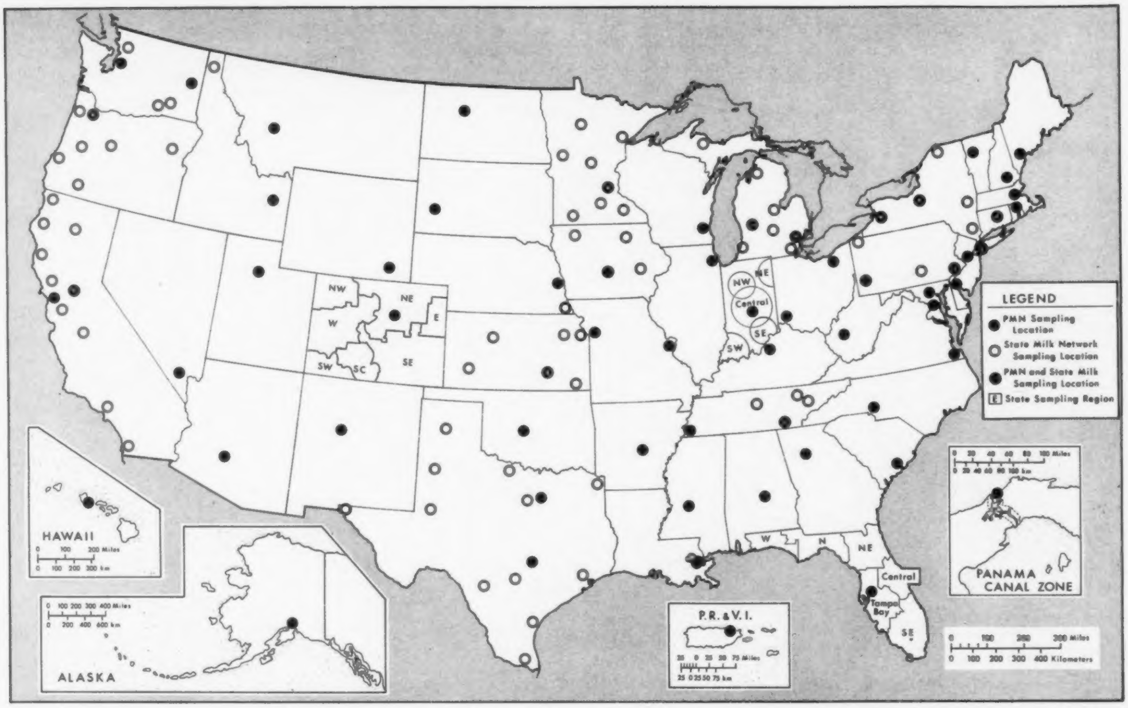

Figure 2. State and PMN milk sampling stations in the United States

for the station as calculated from the preceding 12 monthly averages, giving each monthly average equal weight. Since the daily intake of radioactivity by exposed population groups, averaged over a year, constitutes an appropriate criterion for the case where the FRC radiation protection guides apply, the 12-month average serves as a basis for comparison.

Discussion of current data

In table 2, surveillance results are given for strontium-90 and cesium-137 for March 1972 and the 12-month period, April 1971 to March 1972. Except where noted, the monthly average represents a single sample for the sampling station. Strontium-89, iodine-131 and barium-140 data have been omitted from table 2 since levels at the great majority of the stations for March 1972 were below the respective practical reporting levels. Table 3 gives monthly averages for those stations at which strontium-89, iodine-131, and barium-140 were detected.

Table 3. Strontium-89, iodine-131 and barium-140 in milk, March 1972

Sampling location	Concentration (pCi/liter)		
	Strontium-89	Iodine-131	Barium-140
Calif: Del Norte (State)	9		
Colo: East (State)			40 (2)[a]
Northwest (State)			40
Kans: Hays	8		
Ky: Louisville (PMN)		6 (2)	
Tenn: Clinton (State)		15 (2)	
Fayetteville (State)		10 (3)	

[a] Number in parenthesis indicates number of samples.

Strontium-90 monthly averages ranged from 0 to 16 pCi/liter in the United States for March 1972 and the highest 12-month average was 17 pCi/liter (Little Falls, Minn.), representing 8.5 percent of the Federal Radiation Council radiation protection guide. Cesium-137 monthly averages ranged from 0 to 54 pCi/liter in the United States for March 1972. The highest 12-month average was 54 pCi/liter (Southeast Florida) representing 1.5 percent of the value derived from the recommendations given in the Federal Radiation Council report. Of particular interest are the consistently higher cesium-137 levels that have been observed in Florida (*8*) and Jamaica.

Acknowledgement

Appreciation is expressed to the personnel of the following agencies who provide data for their milk surveillance networks:

Bureau of Radiological Health
Division of Environmental Sanitation
California State Department of Health

Radiation Protection Division
Canadian Department of National Health and Welfare

Radiological Health Section
Division of Occupational and Radiological Health
Colorado Department of Health

Radiological Health Services
Division of Medical Services
Connecticut State Department of Health

Radiological and Occupational Health Section
Department of Health and Rehabilitative Services
State of Florida

Bureau of Environmental Sanitation
Division of Sanitary Engineering
Indiana State Board of Health

Division of Radiological Health
Environmental Engineering Services
Iowa State Department of Health

Radiation Control Section
Environmental Health Division
Kansas State Department of Health

Radiological Health Services
Division of Occupational Health
Michigan Department of Health

Radiation Control Section
Division of Environmental Health
State of Minnesota Department of Health

Bureau of Radiological Pollution Control
New York State Department of Environmental Conservation

Environmental Radiation Surveillance Program
Division of Sanitation and Engineering
Oregon State Board of Health

Radiological Health Section
Bureau of Environmental Health
Pennsylvania Department of Public Health

Radiological Health Services
Division of Preventable Diseases
Tennessee Department of Public Health

Division of Occupational Health
Environmental Health Services
Texas State Department of Health

Radiation Control Section
Division of Health
Washington Department of Social and Health Services

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Food and Diet Surveillance

Efforts are being made by various Federal and State agencies to estimate the dietary intake of selected radionuclides on a continuing basis. These estimates, along with the guidance developed by the Federal Radiation Council, provide a basis for evaluating the significance of radioactivity in foods and diet.

Networks presently in operation and reported routinely include those listed below. These networks provide data useful for developing estimates of nationwide dietary intakes of radionuclides. Programs reported in *Radiation Data and Reports* are as follows:

Program	Period reported	Issue
California Diet Study	July–December 1970	November 1971
Carbon-14 in Total Diet and Milk	July–December 1971	May 1972
Connecticut Standard Diet	January–December 1970	December 1971
Institutional Total Diet	October–December 1971 and 1971 Annual Summary	June 1972
Radiostrontium in Milk	January–December 1970	April 1972
Strontium-90 in Tri-City Diets	January–December 1970	November 1971

SECTION II. WATER

The Environmental Protection Agency and other Federal, State, and local agencies operate extensive water quality sampling and analysis programs for surface, ground, and treated water. Most of these programs include determinations of gross beta and gross alpha radioactivity and specific radionuclides.

Although the determination of the total radionuclide intake from all sources is of primary importance, a measure of the public health importance of radioactivity levels in water can be obtained by comparison of the observed values with the Public Health Service Drinking Water Standards (*1*). These standards, based on consideration of Federal Radiation Council (FRC) recommendations (*2–4*) set the limits for approval of a drinking water supply containing radium-226 and strontium-90 at 3 pCi/liter and 10 pCi/liter, respectively. Higher concentrations may be acceptable if the total intake of radioactivity from all sources remains within the guides recommended by FRC for control action. In the known absence [1] of strontium-90 and alpha-particle emitters, the limit is 1,000 pCi/liter gross beta radioactivity, except when additional analysis indicates that concentrations of radionuclides are not likely to cause exposures greater than the limits indicated by the Radiation Protection Guides. Surveillance data from a number of Federal and State programs are published periodically to show current and long-range trends. Water sampling activities reported in *Radiation Data and Reports* are listed below.

[1] Absence is taken to mean a negligibly small fraction of the specific limits of 3 pCi/liter and 10 pCi/liter for unidentified alpha-particle emitters and strontium-90, respectively.

Water sampling program	Period reported	Issue
Colorado River Basin	1968	March 1972
Interstate Carrier Drinking Water	1971	May 1972
Kansas	January–December 1970	December 1971
Michigan	January–June 1970	November 1971
New York	July–December 1970 and January–June 1971	May 1972
North Carolina	January–December 1967	May 1969
Radioactivity in California Waters	January–December 1970	June 1972
Radioactivity in Florida Waters	1969	January 1972
Radiostrontium in Tap Water, *HASL*	January–June 1971	April 1972
Tritium in Community Water Supplies	1969	December 1970
Tritium Surveillance System	October–December 1971	May 1972
Washington	July 1969–June 1970	March 1972

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Gross Radioactivity in Surface Waters of the United States November 1971

Office of Water Programs
Environmental Protection Agency

The monitoring of gross radioactivity in surface waters of the United States was initiated in 1957 as part of the Water Pollution Surveillance System (formerly National Water Quality Network) of the U.S. Public Health Service. Currently, the program is operated by the U.S. Environmental Protection Agency, Office of Water Programs. Regional offices of the Environmental Protection Agency are responsible for the collection of samples and the entering of the resulting data into the analytical storage and retrieval system. Radioactivity analyses are performed in the centralized radioactivity laboratories of the Office of Water Programs (Cincinnati, Ohio).

The regular reporting of gross radioactivity data in *Radiological Health Data and Reports* was terminated with the publication of data for October 1968 (April 1969 issue). With the publication of data for January 1971, this activity was resumed as a monthly report series. The unpublished data for the time interval of November 1968 through December 1970 will be the subject of a future summary article.

Table 1 presents the gross alpha and beta results for samples collected from 10 rivers

Table 1. Gross radioactivity in U.S. surface waters, November 1971

River and station	Number of grab samples	Gross alpha radioactivity (pCi/liter)		Gross beta radioactivity (pCi/liter)	
		Suspended solids	Dissolved solids	Suspended solids	Dissolved solids
Clinch River:					
Kingston, Tenn	[a]3	<0.6(<0.3, <1.4)	<1.0(<0.3, <2.0)	<4 (<3,5)	<5 (<4,6)
Colorado River:					
Utah-Colo. State Line	1	<3	16	<4	13
Moab Highway Bridge, Utah	[a]4	<2 (<1, <4)	<4 (<3, <7)	<5 (<3,11)	<11 (<8,16)
Moab Mill Creek, Utah	[a]4	<2 (<.4,4)	<5 (<3,7)	<5 (<4,8)	<15 (<8,26)
Lake Granby, Colo	1	<2	<2	<3	<8
Dolores River:					
Bedrock, Colo	[a]4	<2 (<.3,2)	19 (8,28)	12 (5,29)	45 (15,73)
Gateway, Colo	[a]4	<2 (<.3,3)	22 (13,31)	<12 (<3,35)	50 (8,82)
Silt, Colo	1	<.3	4	3	13
Mississippi River:					
Dubuque, Iowa	1	2	3	3	6
Burlington, Iowa	1	3	3	7	7
Ohio River:					
Cincinnati, Ohio	[a]4	<2 (<.6, <2)	<3 (<3, <4)	<3 (<3, <3)	<6 (<4,9)
Roanoke River:					
John Kerr Dam, Va	[a]5	<1 (<.3, <2)	<2 (<.3, <4)	<3 (<2, <6)	<6 (<3,10)
San Miguel River:					
Above Uravan, Colo	[a]4	<1 (<.3, <2)	<12 (<2,24)	<3 (<3, <4)	<11 (<8,19)
Below Uravan, Colo	[a]4	<2 (<2,4)	<18 (<10,32)	<12 (<3,19)	28 (13,69)
Naturita, Colo	[a]4	<1 (<.3, <1)	<4 (<1, <6)	<3 (<3, <3)	<8 (<7, <9)
St. Lawrence River:					
Massena, NY	[a]4	<1 (<.3, <2)	<2 (<1, <4)	<3 (<2, <3)	5 (4,6)
White River:					
Watson, Utah	1	<2	<8	6	9
Yampa River:					
Maybell, Colo	1	<1	1	7	6

[a] Where more than one sample is analyzed during the month, the minimum and maximum are in parentheses.

during November 1971. The analytical procedures used for determining gross alpha and beta radioactivity are described in the 13th Edition of *Standard Methods for the Examination of Water and Wastewater* (*1*). Results are reported for the date of counting and are not corrected to the date of collection. The sensitivity in counting is that defined by the National Bureau of Standards, Handbook 86 (*2*) and is calculated to be <0.2 pCi/liter for gross alpha radioactivity and <1 pCi/liter for gross beta radioactivity measurements.

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SECTION III. AIR AND DEPOSITION

Radioactivity in Airborne Particulates and Precipitation

Continuous surveillance of radioactivity in air and precipitation provides one of the earliest indications of changes in environmental fission product radioactivity. To date, this surveillance has been confined chiefly to gross beta-radioanalysis. Although such data are insufficient to assess total human radiation exposure from fallout, they can be used to determine when to modify monitoring in other phases of the environment.

Surveillance data from a number of programs are published monthly and summarized periodically to show current and long-range trends of atmospheric radioactivity in the Western Hemisphere. These include data from activities of the Environmental Protection Agency, the Canadian Department of National Health and Welfare, the Mexican Commission of Nuclear Energy, and the Pan American Health Organization.

In addition to those programs presented in this issue, the following programs were previously covered in *Radiation Data and Reports*.

Network	Period	Issue
Fallout in the United States and other areas, *HASL*	January–December 1970	December 1971
Mexican Air Monitoring Program	February–December 1971	May 1972
Plutonium in Airborne Particulates	July–September 1971	April 1972
Surface Air Sampling Program, 80th Meridian Network, *HASL*	January–December 1969	February 1972

1. Radiation Alert Network March 1972

Division of Atmospheric Surveillance Environmental Protection Agency

Surveillance of atmospheric radioactivity in the United States is conducted by the Radiation Alert Network (RAN) which regularly gathers samples at 70 locations distributed throughout the country (figure 1). Most of the stations are operated by State health department personnel.

The station operators perform "field estimates" on the airborne particulate samples at 5 hours after collection, when most of the radon daughter products have decayed, and at 29 hours after collection, when most of the thoron daughter products have decayed. They also perform field estimates on dried precipitation samples and report all results to appropriate Environmental Protection Agency officials by mail or telephone depending on levels found. A compilation of the daily field estimates is available upon request from the Air Quality Information Systems Branch, Division of Atmospheric Surveillance, EPA, Research Triangle Park, North Carolina 27711. A detailed description of the sampling and analytical procedures was presented in the March 1968 issue of *Radiological Health Data and Reports.*

Table 1 presents the monthly average gross beta radioactivity in surface air particulates and deposition by precipitation, as measured by the field estimate technique during March 1972.

Stations that reported high readings in March are (air) Santa Fe, N. Mex.—17 pCi/m^3; (precipitation) Nashville, Tenn.—38 nCi/m^2; Oklahoma City, Okla.—25 nCi/m^2; and Portland, Oreg.—20, 22, and 80 nCi/m^2. These elevated levels are attributed to a nuclear detonation on March 18, 1972 by the People's Republic of China.

All other field estimates reported were within normal limits for the reporting station.

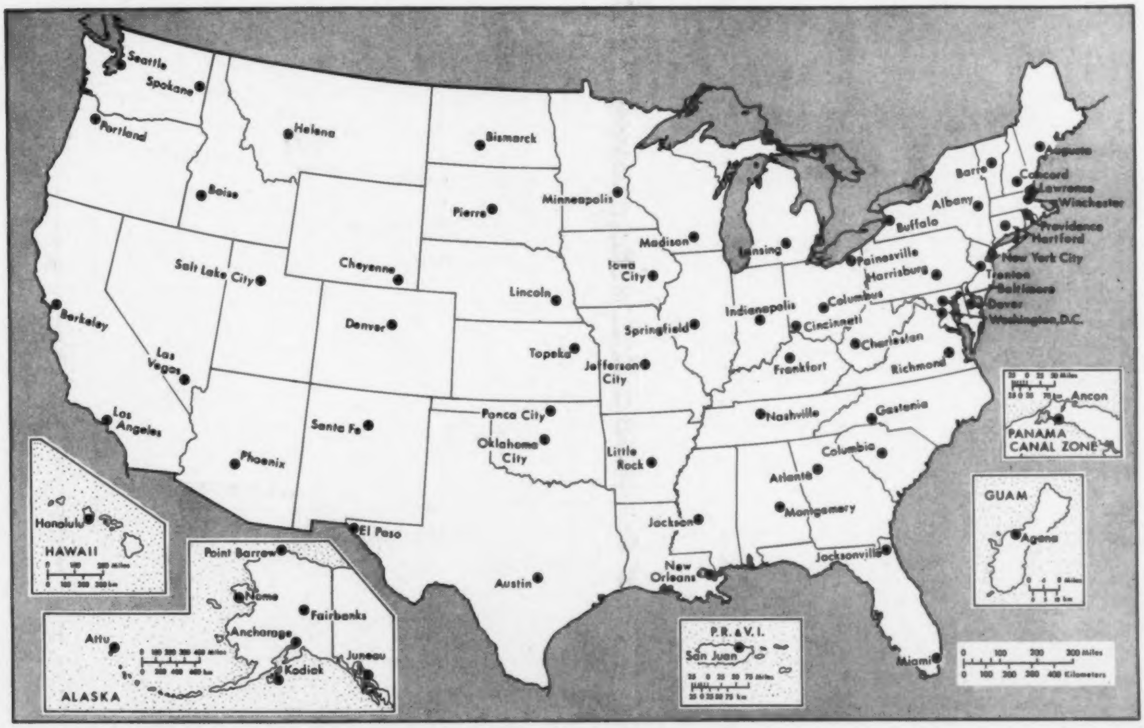

Figure 1. Radiation Alert Network sampling stations

Table 1. Gross beta radioactivity in surface air and precipitation, March 1972

Station location		Number of samples	Gross beta radioactivity (5-hour field estimate) (pCi/m³)			Precipitation				
						Number of samples	Total depth (mm)	Field estimation of deposition		
			Maximum	Minimum	Average[a]			Number of samples	Depth (mm)	Total deposition (nCi/m²)
Ala:	Montgomery	23	2	0	1	5	49	5	49	7
Alaska:	Anchorage	2	0	0	0	0				
	Attu Island	15	0	0	0	0				
	Fairbanks	0				0				
	Juneau	19	8	0	1	7	107	7	107	24
	Kodiak	0				0				
	Nome	0				0				
	Point Barrow	0				0				
Ariz:	Phoenix	13	14	2	5	0				
Ark:	Little Rock	16	0	0	1	0				
Calif:	Berkeley	23	1	2	0	1	5	1	5	0
	Los Angeles	21	2	0	1	0				
C.Z:	Ancon	18	0	0	0	0				
Colo:	Denver	25	6	0	2	1	3	(b)		
Conn:	Hartford	22	1	0	0	11	131	11	131	0
Del:	Dover	22	0	0	0	0				
D.C:	Washington	26	0	0	0	0				
Fla:	Jacksonville	21	2	0	1	3	96	3	96	37
	Miami	16	1	0	0	3	32	3	32	0
Ga:	Atlanta	23	3	1	2	0				
Guam:	Agana	0				0				
Hawaii:	Honolulu	21	12	0	1	2	56	(b)		
Idaho:	Boise	0				0				
Ill:	Springfield	11	2	1	1	0				
Ind:	Indianapolis	22	1	0	0	0				
Iowa:	Iowa City	22	1	0	0	3	46	2	35	0
Kans:	Topeka	22	5	1	2	5	33	5	33	7
Ky:	Frankfort	0				0				
La:	New Orleans	19	0	0	0	8	150	1	7	0
Maine:	Augusta	23	0	0	0	12	175	11	163	0
Md:	Baltimore	10	2	0	1	5	50	5	50	0
Mass:	Lawrence	23	2	0	0	6	110	5	81	0
	Winchester	22	2	0	0	8	167	8	167	0
Mich:	Lansing	22	0	0	0	0				
Minn:	Minneapolis	23	1	0	0	2	18	2	18	5
Miss:	Jackson	21	3	0	1	6	157	6	157	23
Mo:	Jefferson City	23	2	0	1	6	61	6	61	5
Mont:	Helena	21	1	0	1	3	20	3	20	0
Nebr:	Lincoln	18	7	1	3	0				
Nev:	Las Vegas	22	6	0	2	0				
N.H:	Concord	0				0				
N.J:	Trenton	22	1	0	0	10	96	10	96	4
N. Mex:	Santa Fe	15	17	0	2	1	3	1	3	0
N.Y:	Albany	15	0	0	0	0				
	Buffalo	20	0	0	0	0				
	New York City	0				0				
N.C:	Gastonia	18	6	0	2	7	81	(b)		
N. Dak:	Bismarck	21	1	0	0	4	48	4	48	2
Ohio:	Cincinnati	0				0				
	Columbus	4	0	0	0	0				
	Painesville	22	0	0	0	8	77	8	77	21
Okla:	Oklahoma City	7	14	1	2	1	14	1	14	25
	Ponca City	20	6	1	2	2	21	2	21	0
Oreg:	Portland	22	2	0	0	10	116	10	116	130
Pa:	Harrisburg	18	1	0	0	2	30	2	30	5
P.R:	San Juan	13	4	0	2	0				
R.I:	Providence	22	1	0	0	0				
S.C:	Columbia	18	2	0	1	3	41	3	41	7
S. Dak:	Pierre	22	3	0	1	0				
Tenn:	Nashville	21	1	0	0	11	113	11	113	56
Tex:	Austin	19	9	0	3	0				
	El Paso	3	4	1	1	0		(b)		
Utah:	Salt Lake City	31	2	0	1	5	24	5	24	9
Vt:	Barre	19	1	0	0	11	106	11	106	15
Va:	Richmond	22	1	0	0	1	9	1	9	4
Wash:	Seattle	12	3	0	0	7	77			
	Spokane	23	2	0	1	0		(b)		
W. Va:	Charleston	22	9	0	1	9	53	9	53	9
Wisc:	Madison	22	1	0	0	8	51	8	51	4
Wyo:	Cheyenne	21	7	0	2	4	13	4	13	7
Network summary		1,144	17	0	1	201	74	5	61	12

[a] The monthly average is calculated by weighting the field estimates of individual air samples with length of sampling period.
[b] This station is part of the tritium surveillance system. No gross beta measurements are done.

2. Canadian Air and Precipitation Monitoring Program,[1] March 1972

Radiation Protection Division
Department of National Health and Welfare

The Radiation Protection Division of the Canadian Department of National Health and Welfare monitors surface air and precipitation in connection with its Radioactive Fallout Study Program. Twenty-four collection stations are located at airports (figure 2), where the sampling equipment is operated by personnel from the Meteorological Services Branch of the Department of Transport. Detailed discussions of the sampling procedures, methods of analysis, and interpretation of results of the radioactive fallout program are contained in reports of the Department of National Health and Welfare (*1–5*).

A summary of the sampling procedures and methods of analysis was presented in the May 1969 issue of *Radiological Health Data and Reports*.

Surface air and precipitation data for March 1972 are presented in table 2.

[1] Prepared from information and data obtained from the Canadian Department of National Health and Welfare, Ottawa, Canada.

Table 2. Canadian gross beta radioactivity in surface air and precipitation, March 1972

Station	Number of samples	Air surveillance gross beta radioactivity (pCi/m³)			Precipitation measurements	
		Maximum	Minimum	Average	Average concentration (pCi/liter)	Total deposition (nCi/m²)
Calgary	13	0.9	0.0	0.1	65	0.8
Coral Harbour	12	.1	.0	.1	NS	NS
Edmonton	12	.3	.0	.1	85	1.1
Ft. Churchill	12	.2	.1	.1	91	.3
Fredericton	7	.1	.1	.1	230	48.9
Goose Bay	11	.2	.1	.1	105	7.8
Halifax	13	.3	.0	.1	570	129.7
Inuvik	NS				217	3.2
Montreal	12	.4	.0	.0	23	2.8
Moosonee	12	.1	.0	.1	13	.3
Ottawa	11	.9	.0	.1	11	1.1
Quebec	11	.4	.1	.1	13	1.9
Regina	12	.2	.0	.1	331	.4
Resolute	13	.1	.0	.1	15	.1
St. John's, Nfld	8	.1	.0	.1	18	2.1
Saskatoon	12	.1	.0	.1	32	.7
Sault Ste. Marie	10	.1	.0	.1	15	1.3
Thunder Bay	10	.1	.1	.1	20	.8
Toronto	12	.3	.1	.1	19	1.8
Vancouver	11	.4	.0	.1	19	3.4
Whitehorse	12	.1	.0	.1	78	.4
Windsor	11	.2	.0	.1	13	1.0
Winnipeg	12	.2	.0	.1	209	4.3
Yellowknife	9	.1	.1	.1	21	.3
Network summary	258	0.9	0.0	0.1	83	9.3

NS, no sample.

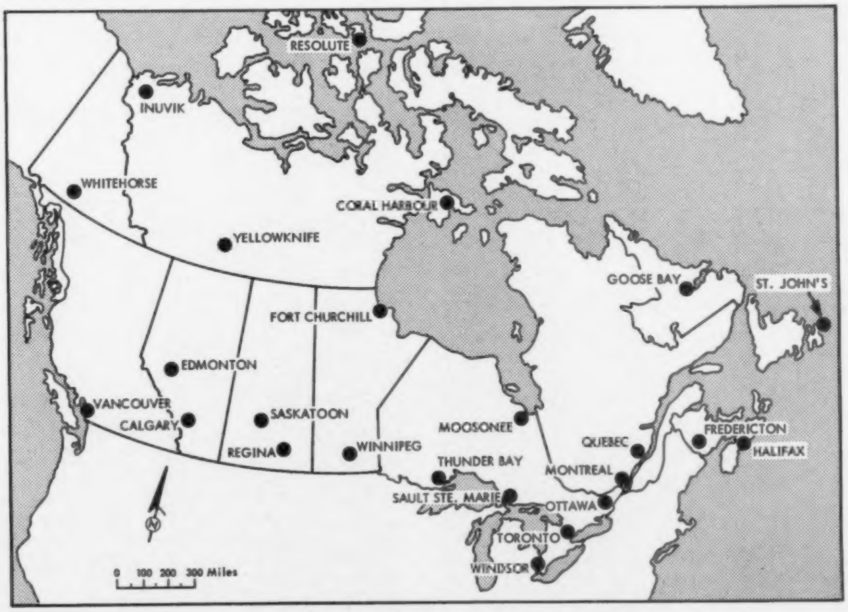

Figure 2. Canadian air and precipitation sampling stations

3. Pan American Air Sampling Program March 1972

Pan American Health Organization and U.S. Environmental Protection Agency

Gross beta radioactivity in air is monitored by countries in the Americas under the auspices of the collaborative program developed by the Pan American Health Organization (PAHO) and the Environmental Protection Agency (EPA) to assist PAHO-member countries in developing radiological health programs.

The air sampling station locations are shown in figure 3. Analytical techniques were described in the March 1968 issue of *Radiological Health Data and Reports*. The March 1972 air monitoring results from the participating countries are given in table 3.

Figure 3. Pan American Air Sampling Program stations

Table 3. Summary of gross beta radioactivity in Pan American surface air, March 1972

Station location		Number of samples	Gross beta radioactivity (pCi/m³)		
			Maximum	Minimum	Average[a]
Argentina:	Buenos Aires	0			
Bolivia:	La Paz	16	0.04	0.00	0.02
Chile:	Santiago	30	.21	.05	.12
Colombia:	Bogota	21	.05	.00	.02
Ecuador:	Cuenca	1	.00	.00	.00
	Guayaquil	10	.06	.00	.02
	Quito	16	.01	.00	.00
Guyana:	Georgetown	6	.01	.00	.01
Jamaica:	Kingston	0			
Peru:	Lima	0			
Venezuela:	Caracas	14	.05	.00	.02
West Indies:	Trinidad	0			
Pan American summary		114	0.21	0.00	0.04

[a] The monthly average is calculated by weighting the individual samples with length of sampling period. Values less than 0.005 pCi/m³ are reported and used in averaging as 0.00 pCi/m³.

4. California Air Sampling Program March 1972

Bureau of Radiological Health California State Department of Public Health

The Bureau of Radiological Health of the California State Department of Public Health with the assistance of several cooperating agencies and organizations operates a surveillance system for determining radioactivity in airborne particulates. The air sampling locations are shown in figure 4.

All air samples are sent to the Sanitation and Radiation Laboratory of the State Department of Public Health where they are analyzed for their radioactive content.

Airborne particles are collected by a con-

Figure 4. California air sampling program stations

tinuous sampling of air filtered through a 47 millimeter membrane filter, 0.8 micron pore size, using a Gast air pump of about 2-cubic-feet per minute capacity, or 81.5 cubic meters per day. Air volumes are measured with a direct reading gas meter. Filters are replaced every 24 hours except on holidays and weekends. The filters are analyzed for gross alpha and beta radioactivity. Analyses are normally made 72 hours after the end of the collection period. The daily samples are then composited into a monthly sample. A gamma scan and an analysis for strontium-89 and strontium-90 are made. Table 4 presents the monthly gross beta radioactivity in air for March 1972.

Table 4. Gross beta radioactivity in California air, March 1972

Station location	Number of samples	Gross beta radioactivity[a] (pCi/m^3)		
		Maximum	Minimum	Average
Bakersfield	31	1.10	0.00	0.31
Barstow	31	5.25	.05	.46
Berkeley	30	.15	.00	.06
Colfax	30	.25	.00	.11
El Centro	29	11.04	.09	1.07
Eureka	30	.43	.00	.08
Fresno	31	1.13	.07	.33
Los Angeles	29	.33	.01	.12
Redding	30	.44	.00	.11
Sacramento	31	.91	.01	.19
Salinas	31	1.52	.04	.26
San Bernardino	31	9.64	.02	1.17
San Diego	31	.54	.01	.16
Santa Rosa	31	.76	.00	.12
Summary	426	11.04	0.00	0.33

[a] Single sample taken at Orange, Calif., March 15, 1972, resulted in a gross beta activity of 0.14. This sample is not included in summary.

5. Plutonium in Airborne Particulates October–December 1971

Office of Radiation Programs
Environmental Protection Agency

The Radiation Alert Network (RAN) of the Division of Atmospheric Surveillance, Environmental Protection Agency, routinely collects airborne particulates samples from eleven selected RAN stations for plutonium analyses. The plutonium analyses were initiated in November 1965, and references to the previous results through December 1969 have been published (*6*).

One-half of each individual air filter from the selected stations is sent to the Northeastern Radiological Health Laboratory, Winchester, Mass. The laboratory analyzes a composite of these samples from each station on a quarterly basis. The results for October–December 1971 are presented in table 5. The minimum detectable activities are 0.020 pCi and 0.015 pCi per sample for plutonium-238 and plutonium-239, respectively. The volume of air sampled varies, generally ranging from 20,000 to 30,000 cubic meters per month.

Other coverage in *Radiation Data and Reports:*

Period	Issue
July–December 1970	June 1971
January–March 1971	November 1971
April–June 1971	March 1972
July–September 1971	April 1972

Table 5. Plutonium in airborne particulates October–December 1971

Location		Plutonium-238 (aCi/m³)	Plutonium-239 (aCi/m³)	Plutonium-239/plutonium-238
Alaska:	Anchorage	ND	8±2	—
Ariz:	Phoenix	2±1	16±3	8±4
Colo:	Denver	ND	17±3	—
Hawaii:	Honolulu	ND	7±1	—
La:	New Orleans	2±1	19±4	10±5
Md:	Baltimore	ND	14±1	—
N.Y:	Buffalo	ND	16±2	—
N.C:	Gastonia	ND	20±3	—
S. Dak:	Pierre	ND	15±2	—
Tex:	Austin	ND	25±2	—
Wash:	Seattle	ND	10±1	—

ND, nondetectable.

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(*1*) BIRD, P. M., A. H. BOOTH, and P. G. MAR. Annual report of 1959 on the Radioactive Fallout Study Program, CNHW–RP–3. Department of National Health and Welfare, Ottawa, Canada (May 1960).

(*2*) BIRD, P. M., A. H. BOOTH, and P. G. MAR. Annual report for 1960 on the Radioactive Fallout Study Program, CNHW–RP–4. Department of National Health and Welfare, Ottawa, Canada (December 1961).

(*3*) MAR, P. G. Annual report for 1961 on the Radioactive Fallout Study Program, CNHW–RP–5. Department of National Health and Welfare, Ottawa, Canada (December 1962).

(*4*) BEALE, J. and J. GORDON. The operation of the Radiation Protection Division Air Monitoring Program, RPD–11. Department of National Health and Welfare, Ottawa, Canada (July 1962).

(*5*) BOOTH, A. H. The calculation of permissible levels of fallout in air and water and their use in assessing the significance of 1961 levels in Canada, RPD–21. Department of National Health and Welfare, Ottawa, Canada (August 1962).

(*6*) BUREAU OF RADIOLOGICAL HEALTH. Plutonium in airborne particulates, April–December 1969. Radiol Health Data Rep 11:552–553 (October 1970).

Air Surveillance Network,[1] March 1972

Western Environmental Research Laboratory
Environmental Protection Agency

The Air Surveillance Network (ASN), operated by the Western Environmental Research Laboratory (WERL), Las Vegas, Nev., consists of 104 active and 18 standby sampling stations located in 21 western States (figures 1 and 2). The network is operated in support of nuclear testing sponsored by the Atomic Energy Commission (AEC) at the Nevada Test Site (NTS), by the Space Nuclear Systems Office at the Nuclear Rocket Development Station which lies within the NTS, and by the AEC at any other designated testing sites.

The stations are operated by State health department personnel and by private individuals on a contract basis. All samples are mailed

[1] The ASN is operated under a Memorandum of Understanding (No. AT(26–1)–539) with the Nevada Operations Office, U.S. Atomic Energy Commission.

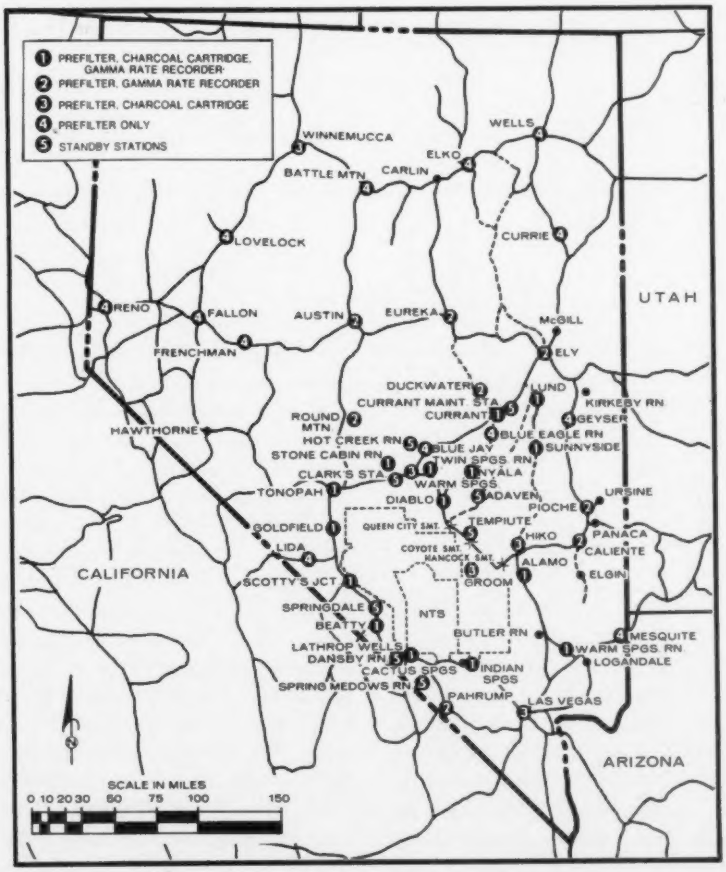

Figure 1. WERL Air Surveillance Network stations in Nevada

Figure 2. WERL Air Surveillance Network stations outside Nevada

to the WERL unless special retrieval is arranged at selected locations in support of known releases of radioactivity from the NTS. A complete description of sampling and analytical procedures was presented in the February 1972 issue of *Radiation Data and Reports.*

Results

Table 1 presents the monthly average gross beta radioactivity in air particulates for each of the network stations. The highest gross beta radioactivity within the network was 110 pCi/m^3 at Furnace Creek and at Indio, Calif. The minimum reported concentration for gross beta radioactivity is 0.1 pCi/m^3. For averaging purposes, individual concentrations which are below the minimum detectable concentration (0.06 pCi/m^3) are assumed to be equal to the minimum detectable concentration. Averages less than the minimum reported level (0.1 pCi/m^3) are reported as $<$0.1 pCi/m^3.

From gamma spectrometry results, fission products in varying combinations of neptunium-239, cerium-141, barium-140, tellurium-132, iodine-131, ruthenium-103, and zirconium-95 were identified on samples collected in Arizona, California, Colorado, Idaho, Kansas, Louisiana, Nebraska, Nevada, New Mexico, Oregon, Texas, Utah, Washington, and Wyoming. Table 2 lists the highest concentrations of these radionuclides, which are attributed to a nuclear detonation by the People's Republic of China on March 18, 1972.

Copies of this summary and listings of the daily gross beta and gamma spectrometry results are distributed to EPA regional offices and appropriate State agencies. Additional copies of the daily results may be obtained from the WERL upon written request.

Table 1. Summary of gross beta radioactivity concentrations in air, March 1972

Location		Number of samples	Concentration (pCi/m^3)		
			Maximum	Minimum	Average[a]
Ariz:	Kingman	31	34.0	<0.1	1.8
	Phoenix	30	19.0	<.1	1.5
	Seligman	31	83.0	.1	3.2
	Winslow	31	32.0	<.1	1.7
Ark:	Little Rock	16	.9	<.1	.1
Calif:	Baker	31	10.0	<.1	.7
	Barstow	31	7.8	<.1	.5
	Bishop	31	33.0	<.1	1.5
	Dealth Valley Junction	31	14.0	<.1	1.0
	Furnace Creek	31	110.0	<.1	4.2
	Indio	31	110.0	<.1	4.6
	Lone Pine	29	45.0	<.1	2.0
	Needles	10	9.1	<.1	1.3
	Ridgecrest	31	7.9	<.1	.6
	Shoshone	31	11.0	<.1	.8
Colo:	Denver	25	7.5	<.1	.4
	Durango	31	21.0	.1	1.2
Idaho:	Boise	31	10.0	<.1	.6
	Idaho Falls	.20	10.0	.1	.5
	Preston	31	7.6	<.1	.6
	Twin Falls	31	8.4	<.1	.6
Iowa:	Iowa City	21	.3	<.1	.1
	Sioux City	28	.4	<.1	.1
Kans:	Dodge City	31	3.5	<.1	.3
La:	Lake Charles	22	1.7	<.1	.3
	Monroe	22	.5	.1	.1
	New Orleans	19	.4	.1	.2
Minn:	Minneapolis	23	.3	<.1	.1
Mo:	Joplin	31	1.9	<.1	.2
	St. Joseph	31	1.5	<.1	.1
	St. Louis	27	.5	.1	.1
Nebr:	North Platte	26	2.7	.1	.3
Nev:	Alamo	31	5.7	<.1	.6
	Austin	25	5.5	<.1	.3
	Battle Mountain	30	.8	<.1	.2
	Beatty	31	13.0	<.1	1.1
	Blue Eagle Ranch (Currant)	22	3.7	<.1	.6
	Blue Jay	31	5.1	<.1	.4
	Caliente	31	5.8	.1	.5
	Currant Ranch	31	3.3	<.1	.4
	Currie	30	.7	<.1	.2
	Diablo	31	4.5	<.1	.4
	Duckwater	27	2.4	<.1	.2
	Elko	31	1.9	<.1	.2
	Ely	31	3.2	<.1	.3
	Eureka	32	3.6	<.1	.3
	Fallini's Twin Springs Ranch	31	4.5	.1	.6
	Fallon	31	1.3	<.1	.2
	Frenchman Station	31	2.4	<.1	.3
	Geyser Maintenance Station	29	12.0	<.1	.9
	Goldfield	28	7.6	<.1	.5
	Groom Lake	29	4.0	<.1	.5
	Hiko	31	16.0	<.1	.9
	Indian Springs	31	17.0	<.1	1.1
	Las Vegas	23	55.0	<.1	2.0
	Lathrop Wells	30	9.5	<.1	.9
	Lida	31	31.0	<.1	1.7
	Lovelock	31	.9	<.1	.2
	Lund	31	3.2	<.1	.4
	Mesquite	31	8.4	<.1	.7
	Nyala	29	2.3	<.1	.4
	Pahrump	23	11.0	.1	.8
	Pioche	29	7.7	<.1	.6
	Reno	31	2.7	.1	.2
	Round Mountain	30	4.8	<.1	.3
	Scotty's Junction	28	4.9	<.1	.6
	Stone Cabin Ranch	31	4.0	<.1	.4
	Sunnyside	26	2.1	.1	.3
	Tonopah	31	6.2	<.1	.6
	Tonopah Test Range	23	7.2	<.1	.5
	Warm Springs Ranch	31	6.8	<.1	.7
	Wells	31	.9	<.1	.2
	Winnemucca	31	1.3	<.1	.2
N. Mex:	Albuquerque	23	27.0	.1	1.5
	Carlsbad	30	21.0	<.1	2.3
Okla:	Muskogee	31	1.6	<.1	.2
Oreg:	Burns	30	25.0	<.1	1.0
	Medford	27	3.2	<.1	.3
S. Dak:	Aberdeen	28	.4	<.1	.1
	Rapid City	30	1.5	<.1	.2
Tex:	Abilene	28	7.6	<.1	.8
	Amarillo	31	7.0	<.1	.6
	Austin	18	5.1	.1	.5
	Fort Worth	29	8.0	.1	.3

See footnote at end of table.

Table 1. Summary of gross beta radioactivity concentrations in air, March 1972—continued

Location		Number of samples	Concentration (pCi/m³)		
			Maximum	Minimum	Average[a]
Utah:	Bryce Canyon	24	5.6	.1	.7
	Cedar City	30	11.0	.1	.8
	Delta	31	1.7	.1	.3
	Dugway	31	2.2	<.1	.3
	Enterprise	31	10.0	<.1	.6
	Garrison	31	5.3	<.1	.4
	Logan	30	5.1	<.1	.4
	Milford	31	12.0	<.1	.7
	Monticello	22	4.0	<.1	.6
	Parowan	31	20.0	<.1	1.2
	Provo	31	1.8	<.1	.3
	Roosevelt	30	6.2	<.1	.4
	Salt Lake City	31	2.9	.1	.3
	St. George	31	5.2	<.1	.7
	Wendover	30	4.5	<.1	.3
Wash:	Seattle	23	2.8	<.1	.2
	Spokane	23	1.4	<.1	.3
Wyo:	Rock Springs	31	17.0	<.1	.8
	Worland	31	1.2	<.1	.2

[a] Individual values less than the minimum detectable concentration (MDC) are set equal to the MDC for averaging. A monthly average less than the minimum reported value of 0.1 pCi/m³ is reported as <0.1.

Table 2. Concentration of radionuclides in air March 1972

Radionuclides	Maximum concentration (pCi/m³)	Location
Neptunium-239	120	Indio, Calif.
Cerium-141	12	Las Vegas, Nev.
Barium-140	1.1	Seligman, Ariz.
Tellurium-132	2.6	Las Vegas, Nev.
Iodine-131	1.3	Seligman, Ariz.
Ruthenium-103	.8	Seligman, Ariz.
Zirconium-95	2.4	Indio, Calif.

SECTION IV. OTHER DATA

This section presents results from routine sampling of biological materials and other media not reported in the previous sections. Included here are such data as those obtained from human bone sampling, Alaskan surveillance, and environmental monitoring around nuclear facilities.

Offsite Surveillance Around the Nevada Test Site [1] January-June 1968

Western Environmental Research Laboratory, EPA,[2] and Nevada Operations Office, AEC

During January through June 1968, 18 announced nuclear tests were conducted in Nevada by the U.S. Atomic Energy Commission (AEC). Three of these tests [3] and two operations of the Phoebus 2A nuclear rocket engine at the Nuclear Rocket Development Station released radioactivity that was detected in the offsite area surrounding the Nevada Test Site (NTS). Under a memorandum of understanding with the AEC and the Public Health Service (PHS), the Southwestern Radiological Health Laboratory (SWRHL) performed offsite radiological monitoring and surveillance in support of these tests.

Operational procedures

Before each event, mobile ground monitors were positioned downwind. If a release occurred, they conducted a monitoring program directed from the AEC control point. In addition to the routine sampling and monitoring provided within 300 miles of each nuclear event, surveillance was extended as necessary to provide adequate coverage. Measurements were made periodically until radioactivity levels returned to background.

Each monitor was equipped with two Eberline E-500B survey meters, an NE-148 scintillation instrument and a Victoreen Radector, Model No. AGB-50B-Sr. Eberline RM11 exposure-rate recorders at fixed locations documented cloud passage. An Air Force U-3A aircraft was used for aerial cloud tracking and two SWRHL Turbo-Beech aircraft provided sampling and long-range tracking.

The Air Surveillance Network (ASN) operated in most of the States west of the Mississippi River (figure 1). The air samplers used were positive displacement vacuum pumps with an average flowrate of 10-cubic feet per minute. The filter media used were a 4-inch Whatman 541 filter paper and an MSA charcoal cartridge. One hundred and seventy-eight samples were collected from about 30 locations in the established milk sampling network. Samples were taken from both commercial dairies and private producers. Vegetation samples were collected after known releases of radioactivity to help delineate the fallout pattern. A total of 426 samples of both potable and nonpotable water was collected from about 80 locations.

Approximately 122 residents in the offsite areas wore film badges and five film badges were placed at each of 107 dosimetry stations. One hundred of these stations were also equipped with three EG&G model TL-12

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[1] This article is a summary of report No. SWRHL-81r, "Off-site Surveillance Activities of the Southwestern Radiological Health Laboratory from January through June 1968."

[2] Formerly the Southwestern Radiological Health Laboratory of the U.S. Department of Health, Education, and Welfare, Public Health Service, Bureau of Radiological Health.

[3] These three tests, Hupmobile, Cabriolet and Buggy I, were reported in reference (*1*).

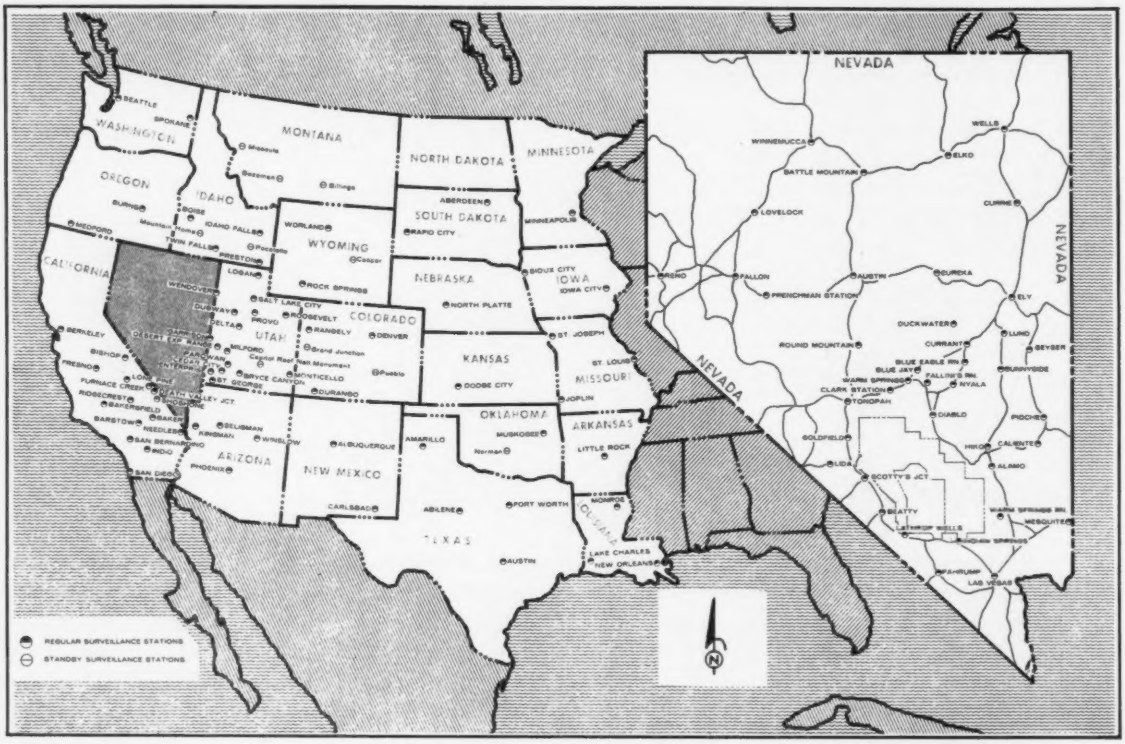

Figure 1. WERL air surveillance network stations

thermoluminescent dosimeters (TLD). The film badge used contained DuPont type 545 film and has a 30 mR lower limit of detection.

A PHS medical officer was available to investigate reports of injuries to persons alleged to be a result of the test series and to maintain liaison with local physicians. No injuries were reported. Veterinarian services were also provided by the PHS to conduct wildlife and domestic livestock investigations.

Analytical procedures

All samples were returned to the SWRHL in Las Vegas for analysis. Air sample particulate filters were counted for beta radioactivity. Selected particulate filters, all charcoal cartridges, water, and milk samples were analyzed for gamma-emitting isotopes. Gamma-ray spectra were evaluated using a matrix technique which allowed for the simultaneous determination of eight nuclides. In addition to gamma analysis, water samples were analyzed for gross alpha and beta radioactivity.

Results

Radioactive material was released offsite following one underground nuclear event and after two Plowshare cratering experiments. These were Hupmobile on January 18, Cabriolet on January 26, and Buggy I on March 12. Two power operations of the Phoebus 2A nuclear rocket reactor released radioactive material detected offsite on June 8 and June 26.

The maximum concentration of gross beta in air was 33,000 pCi/m^3 at Stone Cabin Ranch about 16 miles west and 5 miles north of Warm Springs, Nev. This activity was released by the Cabriolet experiment (table 1).

The maximum external gamma radiation level measured at a populated location during

Table 1. Highest levels of air sampling results in off-NTS areas (based on iodine-131), January through June 1968

Event, date time-on/off	Location azimuth—distance[a]	Collector[b]	Average concentrations during collection period (pCi/m³)					
			Gross beta	Iodine-131	Tellurium-132	Iodine-133	Barium-140	Tungsten-187
Cabriolet 1/26 1020/1500	Stone Cabin Ranch, Nev. 354°—64 miles	PF CC	33,000	290 72	180 56	2,500 2,900	210 37	14,000 4,900
Cabriolet 1/26 0730/1620	Clark Station, Nev. 353°—60 miles	PF CC	15,000	150 110	250 69	2,000 3,300	160 65	9,300 3,600
Buggy I 3/12 1037/1545	Warm Springs, Nev. 360°—81 miles	PF CC	12,000	75 22	120 26	610 310	61 14	3,600 2,200
Buggy I 3/12 1105/1305	Reed Ranch, Nev. 14°—53 miles	PF CC	19,000	46 31	72 40	250 360	5.1 3.1	2,300 1,200
Buggy I 3/12 0705/1615	Blue Jay, Nev. 4°—91 miles	PF CC	3,900	23 20	29 25	160 300	12 7.5	1,500 960

[a] Azimuth and distance from surface zero.
[b] PF, particulate filter; CC, charcoal cartridge.

this period was 65 mR/h following Carbiolet on January 26. This level was recorded by a permanent gamma-ray exposure rate recorder at Clark Station, Nev. This level occurred at 1010 hours on January 26, 10 minutes after cloud arrival and approximately 2 hours and 10 minutes after detonation. By 1030 hours, this level had dropped to about 2 mR/h. A monitor using a portable survey instrument observed a maximum reading of about 43 mR/h during cloud passage near the same location (table 2).

Table 2. Highest levels of ground monitoring results in off-NTS areas, January through June 1968 (readings from portable instruments)

Event and date (1968)	Location	Net gamma radioactivity reading (mR/h)
Cabriolet January 26	16 miles west of Warm Springs, Nev. (unpopulated)	43
Cabriolet January 26	Stone Cabin Ranch, Warm Springs, Nev.	20
Buggy I March 12	4 miles east of Warm Springs, Nev. (unpopulated)	8.5
Hupmobile January 18	4 miles west of Lathrop Wells, Nev. (unpopulated)	.7

The maximum concentration of iodine-131 in milk was 630 pCi/liter from a sample collected at Deeth, Nev. after Cabriolet (table 3).

No water samples collected from sources used for human consumption contained radioactivity attributable to any of the above nuclear events.

The highest exposure measured by a dosimetry device during this period was 8 mR measured by a TLD at Clark Station following Cabriolet. This exposure included that due to cloud passage plus 7 days of residual exposure following cloud passage.

Table 3. Highest levels of milk sample results in off-NTS areas, January through June 1968

Event and location	Date milked (1968)	Concentration (pCi/liter)	
		Iodine-131	Iodine-133
Cabriolet Deeth, Nev.	2/8	630	20
Buggy I Wells, Nev.	3/15	550	1,600
Cabriolet Deeth, Nev.	2/1	160	90
Cabriolet Eureka, Nev.	1/28	110	640
Cabriolet Pancake Summit, Nev.	1/27	110	230
Buggy I Pancake Summit, Nev.	3/15	100	260

Conclusions

Surveillance does not indicate that any individual in an offsite area received an exposure which exceeded the guides established by the AEC and/or recommended by the Federal Radiation Council.

REFERENCE

(1) PUBLIC HEALTH SERVICE, BUREAU OF RADIOLOGICAL HEALTH. Offsite surveillance for three events at the Nevada Test Site, January and March 1968. Radiol Health Data Rep 10:125–127 (March 1969).

Environmental Levels of Radioactivity at Atomic Energy Commission Installations

The U.S. Atomic Energy Commission (AEC) receives from its contractors semiannual reports on the environmental levels of radioactivity in the vicinity of major Commission installations. The reports include data from routine monitoring programs where operations are of such a nature that plant environmental surveys are required.

Releases of radioactive materials from AEC installations are governed by radiation standards set forth by AEC's Division of Operational Safety in directives published in the "AEC Manual."[1]

A summary of environmental radioactivity data follow for the Brookhaven National Laboratory.

[1] Title 10, Code to Federal Regulations, Part 20, "Standards for Protection Against Radiation" contains essentially the standards published in Chapter 0524 of the AEC Manual.

1. Brookhaven National Laboratory[2] July-December 1968

Associated Universities, Inc.
Uptown, N.Y.

The Brookhaven National Laboratory (BNL) operations may affect the environmental levels of radiation in three ways: (1) by radioactivity in the cooling air from the research reactors, (2) by radiation from an ecology forest gamma-ray source, and (3) by low-level radioactive liquid wastes released to a stream that forms one of the headwaters of the Peconic River (figure 1). The radiation levels resulting from reactor air effluent and the ecology forest source are monitored continuously by four stations located at the site boundary. The liquid waste effluent from the laboratory sewage processing plant is monitored continuously at the point where the stream leaves the site.

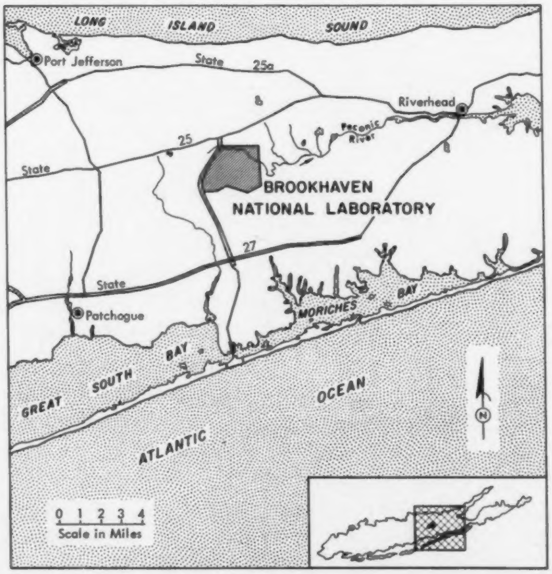

Figure 1. Brookhaven National Laboratory and surrounding area

[2] Summarized from "Effects of Brookhaven National Laboratory on Environmental Levels of Radioactivity during the Second Half of 1968," Associated Universities, Inc., Upton, N.Y. 11973.

Area monitoring

The average weekly radiation levels at the Brookhaven National Laboratory site perimeter (figure 1), due to laboratory operations, are given in table 1. Radiation levels at the northeast perimeter are somewhat greater than at other monitoring stations due to a cesium-137 source located in the nearby forest. The radiation levels at this location were 17 percent of the established Atomic Energy Commission (AEC) radiation protection standard of 500 mrem/a for individuals in the general population. The low levels at the other three perimeter stations are attributed to the Brookhaven Graphite Research Reactor being on standby status during almost the entire period. Values of radiation background levels undisturbed by laboratory operations also have been included in table 1 for purposes of comparison.

Water monitoring

The liquid waste effluent from the laboratory sewage processing plant is monitored continuously at the point where the stream leaves the BNL site. The average concentration and total amount of gross beta radioactivity in the liquid waste effluent, at the site boundary, are shown in table 2 for July–December 1968.

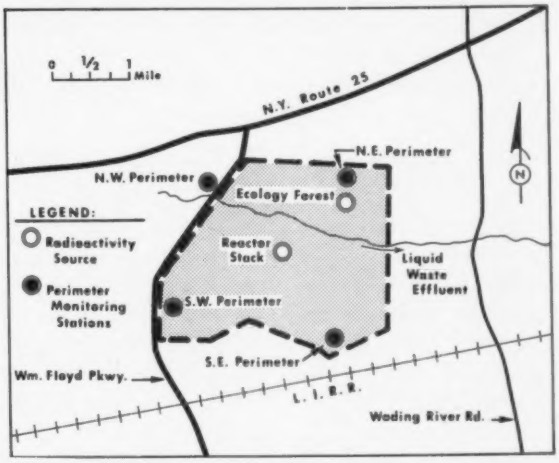

Figure 2. Brookhaven National Laboratory monitoring station locations

Analysis of composite samples of the effluent has shown that, on the average, less than 20 percent of the radioactivity consists of strontium-90 and that no appreciable amounts of radioactive iodine or bone-seeking radionuclides, such as radium, are present. Under these conditions, the applicable AEC radiation protection standard for discharge of liquid waste to uncontrolled areas would be 1 nCi/liter. The observed concentration at BNL was 1 percent of the standard.

Table 1. External gamma radioactivity at BNL site perimeter due to laboratory operations,[a] July-December 1968

1968	Average exposure rates (mR/week)			
	Northwest perimeter	Southwest perimeter	Southeast perimeter	Northeast perimeter
July	0.00	0.00	0.00	1.92
August	.00	.00	.00	2.11
September	.00	.00	.00	1.95
October	.00	.00	.00	1.68
November	.02	.00	.00	1.52
December	.00	.00	.00	1.27
Highest weekly reading (July–December)	0.08	0.00	0.00	2.28
Average undisturbed background (July–December)	1.75	1.72	1.81	1.71
1968 summary:				
January–June	0.08	0.08	0.19	1.74
July–December	.00	.00	.00	1.74
January–December	.04	.04	.10	1.74
Highest weekly reading	.49	.46	1.36	3.50
Average undisturbed background (January–December)	1.74	1.97	1.82	1.77

[a] Due principally to argon-41 in reactor cooling air, and at the northeast perimeter, to the ecology forest cesium-137 source.

Table 2. Gross beta radioactivity in liquid waste effluent at BNL site boundary July-December 1968

1968	Volume of flow (gallons/day)	Average beta radioactivity concentration (pCi/liter)	Total beta radioactivity concentration discharged (mCi)	Tritium concentration (nCi/liter)	Tritium radioactivity (Ci)
July	885,000	14	1.4	2	0.2
August	968,000	15	1.6	8	.8
September	770,000	11	1.2	4	.4
October	885,000	10	.9	37	3.5
November	819,000	15	1.3	35	3.0
December	740,000	9	.9	14	1.2
January–June	896,000	18	10.8	14	8.5
July–December	839,000	13	7.3	16	9.1
January–December	866,000	15	18.1	15	17.6

Most gross beta measurement instruments are not sensitive to low energy beta emitters, such as tritium, for which special analysis methods must be employed. The concentration and amounts of tritium found during this reporting period in the laboratory's liquid waste effluent are also shown in table 2. The applicable AEC standard is 3 μCi/liter, averaged over a period of 1 year. The observed concentration of tritium at BNL was 0.5 percent of this standard.

Recent coverage in *Radiation Data and Reports:*

Period	Issue
January-June 1968	June 1972

Reported Nuclear Detonations, June 1972

(Includes seismic signals presumably from foreign nuclear detonations)

There were no nuclear detonations reported by the U.S. Atomic Energy Commission for June 1972 for the United States.

The U.S. Atomic Energy Commission announced that the United States recorded seismic signals, presumably from a Soviet underground nuclear explosion. The signals originated at about 9:30 p.m. (EDT), June 6, 1972, at the Semi-palatinsk nuclear test area and were equivalent to those of an underground nuclear explosion in the intermediate yield range of 20–200 kilotons.

Information in this section is based on data received during the month, and is subject to change as additional information may become available. Persons requiring information for purposes of compiling announced nuclear detonation statistics are advised to contact the Division of Public Information, U.S. Atomic Energy Commission, Washington, D.C. 20545.

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SYNOPSES

Synopses of reports, incorporating a list of key words, are furnished below in reference card format for the convenience of readers who may wish to clip them for their files.

RADIATION EXPOSURE TO STAFF CARDIOLOGIST VS SENIOR RESIDENT CARDIOLOGIST AND PATIENTS DURING CARDIAC CATHETERIZATION. *Stanley J. Malsky, Jacob Haft, David Hayt, Lawrence Gould, Charles Blatt, Donald F. Simon, and Bernard Roswit. Radiation Data and Reports*, Vol. 14, July 1972, pp. 387–391.

A study was conducted to compare the radiation exposure received by a senior resident cardiologist to that of the staff cardiologist when performing a full cardiac procedure. In addition, patient exposure values were obtained. The staff cardiologist was found to receive approximately 50–60 mR/procedure in the chest region and the senior resident received approximately 61 to 73 mR. The exposure to patients as calculated from tabletop measurements varied from 24 to 73 R.

KEYWORDS: Cardiac catheterization, diagnostic radiology, medical x rays, radiation exposure.

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